Testing the CVC Hypothesis in the β Decay of ^{14}O

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The A = 14 system offers an opportunity to test the Conserved Vector Current hypothesis of the electroweak interaction. CVC relates the width of an M1 transition in a nucleus with the shape factors of the beta decay spectra to the same nucleus from isospin analog states. This implication of CVC has been tested in the A=12 system by examining the shape factors of $^{12}B \rightarrow {}^{12}C$ and $^{12}N \rightarrow {}^{12}C$. However, the agreement with CVC is rather poor, and several experiments disagree.[1] The A = 14 system offers another CVC test with larger shape factors. The shape factor is a deviation of the $\beta_\pm$ spectrum from the allowed-order shape by a factor $S(E) = 1 + a_\pm E$, where E is the total β energy. The difference $(a_+ - a_-)$ depends on the weak magnetism form factor, which is related via CVC to the 2.3 MeV γ decay rate in ^{14}N.

We intend to measure the shape factor in the $0^+ \rightarrow 1^+$ branch of the β+ decay of ^{14}O using a flat-field magnetic spectrometer with a multi-wire proportional chamber detector. Because the half-life of ^{14}O is only 71 seconds, it must be produced on-line at the 88” Cyclotron. To avoid error in the spectrum from a thick source for the spectrometer, we will produce a beam of radioactive ^{14}O using an ECR ion source. The ^{14}O is produced by $^{12}C(^3He, n)^{14}O$ using a heated carbon target. The C-O gas evolving from the target is transported in a closed gas line to the ion source on the cyclotron vault roof. The ionized ^{14}O will be implanted into a thin foil source at nearly uniform depth. Positrons from the implanted ^{14}O then enter the spectrometer. The ECR ion source has been tested and has demonstrated 26.5% ionization efficiency for $^{16}O^{6+}$ from CO.

During 1998, we tested our production target and transport hardware and were able to achieve 2×10^7 atoms per second of ^{14}O at the input to the ion source, using a ^3He beam current on target of 2 p-μA. (Fig. 1) This production rate is sufficient to perform the shape factor measurement to an uncertainty of 0.005 / (MeV) in 45 hours of operation. This copious production was achieved using a novel physical form of graphite – reticulated vitreous carbon “foam” – as a resistively heated oven element. Our target production as a function of temperature is shown in Fig. 1. During 1999, we expect to integrate ^{14}O production with the new ECR ion source. We hope to achieve the ionization and implantation steps during 1999.

We also intend to measure the branching ratio of the superallowed $0^+ \rightarrow 0^+$ transition in ^{14}O. This branching ratio has been measured only once,[2] and is important for a precise measurement of the V_{ud} element in the CKM matrix. This requires a precise measurement of the β spectrum at several spectrometer B fields to deconvolve the branches of the beta decay.

Footnotes and References

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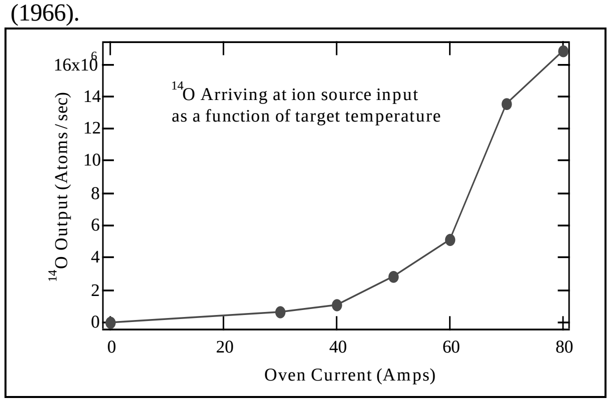

Fig. 1 Production of ^{14}O as a function of target temperature.